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shaking-up by shocks, and of the persistent odor of the sulphur," the anchorage was a safe one. The first impression of the volcano was its likeness to an immense lime-kiln; though when the intermittent masses of smoke from the crater and from the fissures, which in some cases extended to the water's edge, gave a clearer view, its jagged mouth and sides dispelled the illusion. At intervals the side crevices gave out only faint, pale ribbons of smoke, and then it was found that their edges were covered with incrustations of sulphur and of a white crystalline formation. A thermometer inserted an inch and a half below the crust reached its limit (250° F.) in a few seconds, the air temperature being at the same time 40° F. The crust was warm, though not unbearably so; but a stick placed against the heated rock blazed instantly.

As a rule, vibratory motion of the whole mass could not be discovered; though, with instruments, the explorer believed vibrations could be continuously detected. This statement rests upon the fact, that, when taking observations with the artificial horizon, the mercury was agitated so constantly as to permit accurate sights only at long intervals. Upon one occasion, while climbing the sides of the volcano, there was a most sensible vibration of the whole mass; and at the anchorage many shocks, both single and successive, were felt.

Rumbling sounds, and a dull roar similar to the discharge of distant cannon, were heard at intervals; and, though flames were seen only upon two occasions, yet this is believed to have been due to the little darkness of the season at that latitude.

The mass of the volcano was found "to be of a species of sand rock, with large black rocks scattered about the crust." No traces of lava, and but small quantities of pumice, were found. In some places the sand and cinders were ground to a fine powder, ankle-deep as a rule, but so yielding in places as to prevent an extended survey. The most careful examination revealed no trace of shells, though many of the rocks at the base "looked as if they had been exposed for a long period to the action of the water . . . and some of the rocks under water were still smoking." When the compass was taken ashore, marked local action was so noticeable as to prove the presence of iron.

Near the base of the volcano the water bubbled and broke, as if boiling, but no difference was found in the surface and bottom temperatures; and at the anchorage, where the same ebullition was apparent, there was a difference of one degree only between the same points.

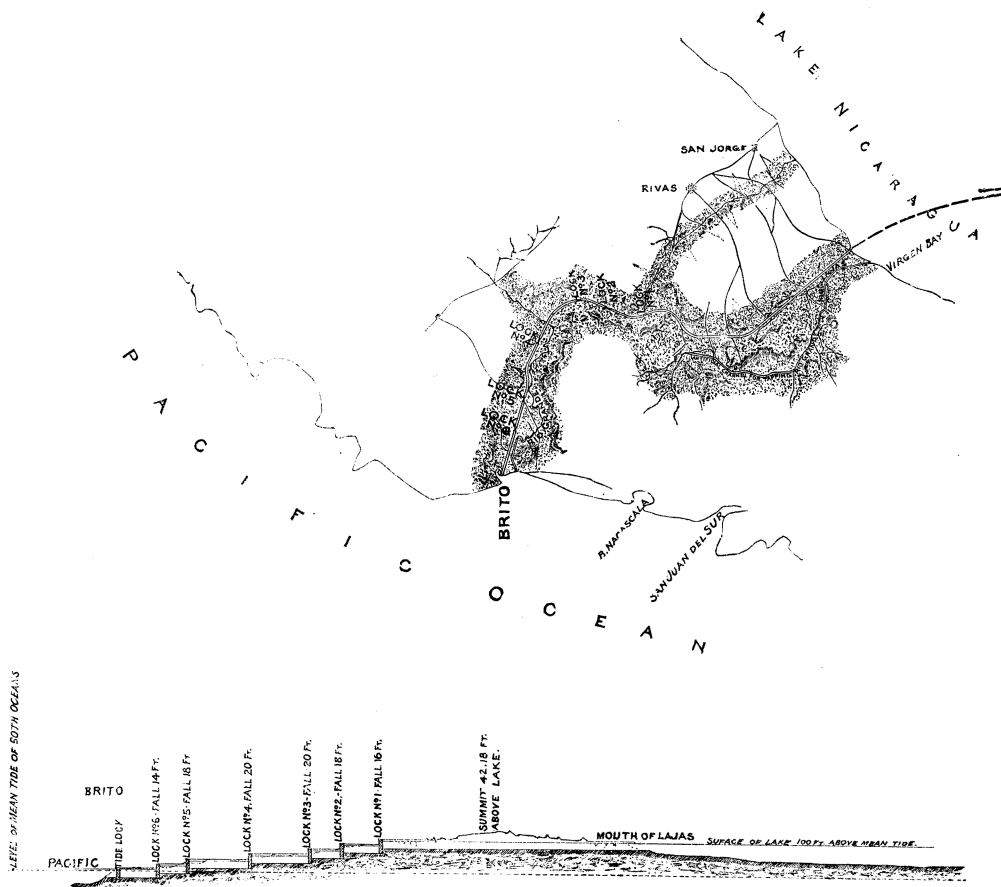
Though one of the party reached the summit of the crater, no estimate of its periphery, depth, and apparent area, could be made. By repeated measurements the altitude of its summit was found to be three hundred and fifty-seven feet. Some discrepancies were found on the printed hydrography of the place; for example, the reef charted as extending from Bogosloff to Umnak does not exist.

Birds were found upon the old volcano in enormous numbers; gulls, shags, and sea-crows being so numerous, that, "when a gun was fired, the heavens would become black with them," and such as flew into the smoke of the belching hill, as many did, immediately perished. The sand-spit on the eastern shore, and the base rocks, were the resting-places for hundreds of sea-lions. No fish could be found, though lines were frequently put over; and, strangely enough, it is recorded, that, three days before the eruption on Augustin Island, all the fish are said to have disappeared from Port Graham.

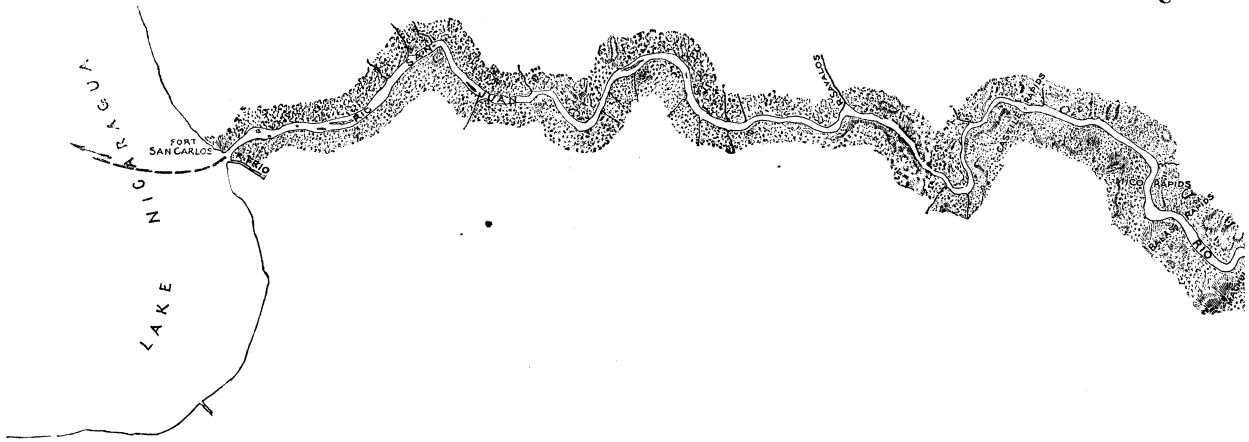
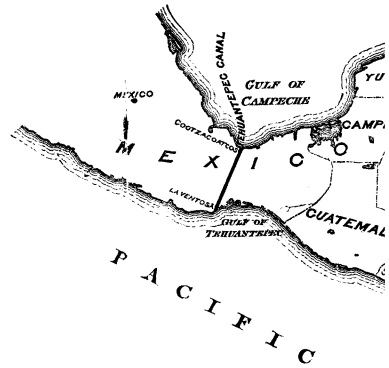
CANAL ROUTES BETWEEN THE ATLANTIC AND THE PACIFIC.

INTERNAL canals, or canals connecting different parts of the same country, are now rarely constructed; and many formerly in use have been dried up, and superseded by railways; while ship-canals are becoming more common and of greater importance than internal canals have ever been. The opening of the Suez canal has brought back to the Mediterranean the commerce of the east. Greece will soon have a canal through the Isthmus of Corinth, with its outlet at the Piræus of Athens; and the Dutch are constructing a ship-canal to connect Amsterdam directly with the sea. In England a canal is to be built from the ocean to Manchester, which will make that city a seaport town, and transfer to it a large portion of Liverpool's commerce. In France a canal is proposed between the Mediterranean and the Bay of Biscay; and in Massachusetts a canal is cutting across Cape Cod.

Besides the Panama canal, there are two projects for connecting the Atlantic and Pacific Oceans,—the Tehuantepec route, advocated by Capt. Eads, the engineer of the great railway bridge at St. Louis and of the water-way at the mouth of the Mississippi River; and the Nicaragua route, by Capt. Bedford Pim of the British navy, for a long time favorably known to the scientific world. He was the first man who marched from a ship coming



Brito to Greytown, 173.57 miles.
Vertical fifty times greater than horizontal scale.



FORT SAN CARLOS
ENTRANCE TO
RIO SAN JUAN

FALLOF WATER IN RIVER 1 INCH PER MILE

PLAN AND PROFILE OF THE NICARAGUA INTE.

Compiled from various surveys, by A. G. MENOCAL, civil engineer, U



SCIENCE, November 7, 1884.

through Baffin's Bay to the Navigator, — a vessel which had entered the ice through Bering Strait, and saved the crew of the latter from starvation; thus for the first time solving the north-west passage, and proving it impracticable for commerce. Later, he was the first to enter Suez on the locomotive from Cairo, and, with the late Robert Stephenson, made a careful study of the isthmus, and of the hydrographic qualifications of the harbors at Suez and Port Said. Subsequently he spent three seasons, with a large staff at great labor and expense, in making a profile of the Nicaragua route from Greytown, through Lake Nicaragua, to the Pacific Ocean.

Count de Lesseps proposes to make the Panama canal broad enough and deep enough to allow the passage of the largest ships from the Atlantic to the Pacific. Mr. Eads proposes to construct a canal and railway across the Tehuantepec route, and, in cradles adjusted to large cars, to carry the vessels from ocean to ocean over this railway; while Capt. Pim's project is to dig a canal eight feet in depth, to raise the vessels by hydraulic lifts, and float them into a shallow dock on pontoons drawing six feet of water, claiming that in this way a vessel can cross the isthmus as quickly as by a deep-water canal, and that, by clearing the ship's bottom of barnacles during the passage, a further saving of time may be effected.

Capt. Pim objects to the Panama route on the grounds that the difference in the height of the water at Aspinwall and Panama will render it difficult, and without locks impossible, for vessels to enter and leave the canal; that Panama is within the equatorial calm-belt, where the periodical calms continue ten or eleven months in the year (his own vessel, the *Herald*, was towed 700 miles from the land before reaching a breath of wind), and that on this account it will take a longer time for sailing-vessels to go to San Francisco by the Panama canal than by Cape Horn.

He says, that, when the Panama railway was built, it was expected that large quantities of oil would be shipped over it; but no whaler has ever reached Panama. He estimates that the cost of this route will be not less than \$150,000,000, or nearly twice as much as that of the Nicaragua route, the U. S. engineers estimating the cost of the latter at \$82,000,000. The proposed route through Nicaragua (see the accompanying chart) is by a canal from Greytown to a dam to be constructed on the San Juan River, from there, by the river, to Lake Nicaragua, across the lake, and thence by a canal to the Pacific Ocean, making a total

distance of 173.57 miles. The surface of Lake Nicaragua is 107 feet above the level of the Atlantic, and the height of the land between the lake and the Pacific is 147.7 feet, requiring a cut of 40 feet to bring the canal to the lake-level. This necessitates a series of five locks between the Atlantic and Nicaragua, and seven between the lake and the Pacific. There was formerly an excellent harbor at Greytown, but it was filled up by the silt coming down the river; and at present there are no good ports on either side of the route, though it is believed that they can be constructed at a moderate expense. It is proposed to change the course of the river so as to prevent the silt from coming down, and then to excavate the harbor at Greytown; while at Brito, on the Pacific coast, a harbor can be made by the construction of two breakwaters.

Nicaragua is 600 miles nearer San Francisco than Panama; and, as stated, sailing-vessels from the latter must make a long *détour* in order to obtain the advantage of the monsoons; making a difference of 2,100 miles, or fourteen days, in favor of Nicaragua, though on the return trip the difference is only about 600 miles, or four days. Although tonnage by steamers is increasing, yet at the present time the tonnage of sailing-vessels largely exceeds that of steamers. The tonnage of sailing-vessels in 1877, in the United States, was twice as great as that of steam-vessels, though at the present time it is only one-third more.

The difference in favor of the route from Nicaragua to Japan, China, and the Sandwich Islands, is over 800 miles, while on the return it is only 600 miles, and to India and Australia, 400 miles. It is also stated that vessels can sail in a shorter time from Nicaragua to Valparaiso and Callao, than from Panamá, although the distance is considerably greater. The saving for steamers, however, will not be nearly so great, amounting only to the direct distance between the two Pacific termini; that is, about 1,300 miles for the round trip between Panama and San Francisco, or five days in a ten-knot steamer.

The committee appointed by our government in 1877, consisting of Gen. A. A. Humphreys (chief of engineers), Capt. C. P. Patterson (superintendent of the U. S. coast-survey), and Commodore Daniel Ammen, 'after a long, careful, and minute study' of the several surveys of the various routes across the continent, reported unanimously in favor of the Nicaragua route as possessing "greater advantages, and offering fewer difficulties from engineering, commercial and economic points of view, than any

one of the other routes shown to be practicable."

Admiral Ammen of the U.S. navy, in his speech on the Nicaragua route before the American association for the advancement of science at Philadelphia, said that there were 2,000,000 tons of grain produced on the Pacific coast by English-speaking people, which find a market around Cape Horn, mostly in English ports; and that there were vast quantities of timber-lands, extending from Puget Sound to Bering Strait, with the best quality of lumber, which can be shipped through this canal most advantageously. From time to time, a good many estimates of the tonnage that would use the canal have been made, nine of which, obtained by the U.S. commission, range from 3,000,000 to 6,000,000 tons of freight, and give an average of 3,804,000 tons per year. The estimated toll is three dollars per ton, in addition to the port charges and other dues; but the actual expense to the vessel will depend upon the rule adopted for ascertaining the charge, and whether the tonnage is charged upon the actual amount of cargo carried, or on the gross tonnage of the vessel. The latter, which is the method proposed by Mr. de Lesseps, would make the actual cost about six dollars for each ton of merchandise carried.

"The tonnage of the world in 1870 amounted to 17,963,293 tons, and, in 1879, to 20,395,815 tons. These amounts were made up of steam and sail tonnage, as follows:—

Years.	Steam.	Sail.
1870	2,466,498	15,496,795 tons.
1879	4,366,221	16,029,594 "
Gain in 9 years	1,899,723	532,799 tons.

"From this it will be seen, that, while the sailing-tonnage has actually increased, it has not done so at a rate to compare with the increase of the steam-tonnage, which has been facilitated by many causes, prominent among which was the opening of the Suez Canal. Sailing-vessels cannot use this canal to advantage: hence the increased commerce resulting from its construction has called into existence much of the increased steam-tonnage. It is very probable, that, in the event of the opening of a canal by way of Nicaragua, the sailing-tonnage would increase at a remarkably rapid rate, as this route lies in a region which is highly favorable to sailing-vessels."

GARDINER G. HUBBARD.

CERTAIN PRINCIPLES OF PRIMITIVE LAW.

A DEFINITION of the term 'law,' that will hold good under all circumstances, must be divested of the many theories of its origin, the source of its authority, and its ethical characteristics, which are expressed or implied in customary definitions, and laws must be considered as objective facts. The following definition will perhaps do under all circumstances: *A law is a rule of conduct which organized society endeavors to enforce.*

In civilization, law is theoretically founded on justice; but in savagery, principles of justice have little consideration. There are two fundamental principles at the basis of primitive law: viz., first, controversy should be prevented; second, controversy should be terminated. A third is derivative from them; namely, infraction of law should be punished. These principles enter into primitive law in many curious ways.

It was customary among the tribes of North America for individuals to mark their arrows in order that the stricken game might fall to the man by whose arrow it had been despatched.

A war-party of Sioux surprised a squad of sleeping soldiers, who were all killed at the first volley from the Indians. Their arms, blankets, and other property were untouched, because, the attacking party being large, it could not be decided by whose bullets the soldiers were killed.

It has been widely believed that the practice of placing the property of deceased persons in their graves when they are buried has its origin in religion, and testifies to the universal belief that the dead live again, and will need such articles in their new life. But many tribes of North America who have not yet been long in contact with white men avow, that, there being no owner for the property, its disposition might lead to controversy, and hence it is destroyed. Many examples of this fact have been collected. Ownership to the greater part of property in savagery is communal, some classes of property being owned by the clan, others by the tribe; and for such there is no proper inheritance, as the clan and tribe do not die; but purely personal property is inherited by the grave. It seems probable that such is the origin of the custom of burying various articles with the dead. Subsequently it has religious sanctions thrown about it, as have many social customs.

There is a law, among the tribes of North